

Appl. No. 09/396,052
Amdt. dated 14 May 2003
Reply to Office action of 15 April 2003

Attorney Docket No. 57.0307 US NP

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This listing of claims will replace all prior version, and listings, of claims in the application:

Listing of Claims:

Claims 1-12 (withdrawn).

Claim 13 (original) An apparatus for hydrocarbon exploration comprising:

a seismic source adapted to impart seismic energy into the earth at a predetermined time;

at least three seismic receivers each adapted to measuring the seismic energy from the seismic source that has been reflected from one or more subterranean earth structures outside the near-site structure, the seismic receivers located substantially in a plane at or near the earth surface, wherein said at least three seismic receivers are spaced less than about 1 meter from each other to form a receiver cluster.

Claim 14 (original) An apparatus according to claim 13 further comprising a fourth seismic receiver located less than about 1 meter from the at least three seismic receivers and wherein each of the receivers are one-component geophones.

Claim 15 (original) An apparatus according to claim 14 wherein the each of the one-component geophones are positioned in a diamond-shaped pattern and each of the sensed components are in different directions within the plane.

Claim 16 (original) An apparatus according to claim 13 wherein each of the receivers are geophones capable of measuring at least three components.

Claim 17 (original) An apparatus according to claim 16 wherein the earth surface is the surface of land.

Claim 18 (original) An apparatus according to claim 16 wherein the earth surface is the sea bottom.

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Claim 19 (original) An apparatus according to claim 13 wherein a hydrocarbon reservoir is located near the one or more subterranean earth structures outside the near-site structure.

Claim 20 (original) An apparatus according to claim 16, wherein the at least three components of each of the geophones are transmitted to a processing unit to calculate an approximation of the full wavefield at the position of the cluster making use of a free surface boundary condition.

Claim 21 (original) A method for hydrocarbon exploration comprising:

impairing seismic energy into the earth at a predetermined time such that the seismic energy travels through the earth and reflects off of one or more subterranean earth structures outside the near-site structure;

positioning at least three seismic receivers substantially in a plane at or near the earth surface, wherein the seismic receivers are spaced less than about 1 meter from each other to form a receiver cluster;

receiving seismic energy imparted by the seismic source that has been reflected off of the one or more subterranean earth structures;

storing seismic data that represents the received seismic energy; and

analyzing the data such that characteristics of one or more hydrocarbon reservoirs can be determined.

Claim 22 (original) A method according to claim 21 wherein the step of analyzing comprises the step of measuring the curl and divergence of the wavefield from the seismic data, thereby identifying seismic components within the seismic data.

Claim 23 (original) A method according to claim 22, wherein P-wave and S-wave components are separately identified.

Claim 24 (original) A method according to claim 23, wherein up-going and down-going wavefield components are identified from the seismic data.

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Claim 25 (original) A method according to claim 24, wherein the step of analyzing further comprises attenuating unwanted seismic components from seismic data.

Claim 26 (original) A method according to claim 25, wherein the step of analyzing further comprises the step of averaging the curl and divergence over the selected plane or volume of acquisition.

Claim 27 (original) A method according to claim 26, wherein the step of analyzing further comprises the step of defining the selected plane or volume of acquisition to be small compared to the wavelength of seismic waves to be detected.
